

a *Papilio* mimicking them obtains no protection in the vicinity of these birds.

5. There is no bird in Ceylon known to eat butterflies that distinctly discriminates as an adult between one species of butterfly and another.

6. It has been shown that there is a great destruction of butterfly life in the dry zone, and that here, if anywhere, Müllerian or Batesian mimicry might be induced, but the destroyers are largely migratory and their attacks are not selective.

7. That the number of broods of butterflies which occur between the termination of tasting experiments in one year and the commencement of them in the next is so great that any influence which could be wrought by such is almost inappreciable.

8. The little evidence available shows that young Ceylon birds imitate their parents in their choice of food; but as regards butterflies, the fact that there is no discrimination shown by adults leads one to conclude either that few or no tasting experiments were undertaken in youth, or, what is more probable, that their taste with regard to them is indifferent.

9. It is questionable, and so far as an accurate knowledge of one species goes it is definitely shown, that that form of mimicry represented by wet and dry season forms (cryptic defence) is not produced for the protection of the species, inasmuch as many (four) succeeding broods of the wet weather form may be found under dry season conditions without detriment to the species.

34. The Distribution of the Avian Genus *Megapodius* in the Pacific Islands. By J. J. LISTER, M.A., F.R.S., F.L.S., F.Z.S.

[Received and Read May 9, 1911.]

(Text-figure 166.)

The Megapodiidae or Mound Builders are, as is well known, large birds, with comparatively feeble powers of flight, constituting a family of the order Gallinae. They are distributed over the islands of the East Indian Archipelago and Western Pacific, from the Philippines and Borneo to the New Hebrides, and are found in several parts of the continent of Australia. Four outlying species of the genus *Megapodius* are found in the Nicobar, the Pelew, and the Marianne Islands, and, far out in the Pacific, on the little island of Niuafoou, belonging to the Tongan group.

As we cannot suppose that the birds found in these outlying islands, remote from the other species, can have flown across the intervening tracts of ocean, we are presented with the problem: How did they reach these islands?

The solution to which M. Oustalet gives his adhesion, in his Proc. Zool. Soc.—1911, No. LII,

monograph on the Family*, is that all these localities have been at one time connected by land, which has since been to a large extent submerged.

Text-fig. 166.

Map illustrating the Distribution of the Genus *Megapodius*.

Wallace had, in 1876 †, expressed the opinion that the Megapode

* "Monographie des Oiseaux de la famille des M^egapodiid^es." Ann. d. Sciences naturelles, 6 s^er. t. 10 & 11, 1880-81.

† Geographical Distribution of Animals. London, vol. ii. p. 342.

of the Nicobar Islands had probably been introduced by the Malays, but Oustalet cannot regard this explanation as plausible, on the ground that "we possess no positive proof of the domestication of Megapodes by the Malays or the savage people inhabiting the Oceanic Islands."

My object in this paper is to point out the reasons which appear to me to make it probable that the distribution of the genus *Megapodius* has been, as Wallace suggested in the case of the Nicobar bird, considerably modified by human agency; and that the species found in these outlying Pacific islands have been carried there by man.

Since Oustalet published his monograph the Megapodiidæ have been again reviewed by Ogilvie-Grant in his Catalogue of the Game Birds in the British Museum* ; and in 1901 Rothschild and Hartert † gave their revision of a portion of the genus *Megapodius*.

The determination of the limits of the species of this genus is difficult on account of the variation in size and colour presented by the birds inhabiting the same locality, and the fact that the characters of those from different localities often merge into one another. On comparing the results arrived at by the authors mentioned, we find that nineteen species were enumerated by Oustalet. If we take from these *M. wallacei*, which has been placed by Ogilvie-Grant in a separate genus (*Eulipoa*), and *M. brenchleyi* and *M. brazieri*, which had then been described only from eggs or young birds, there remain sixteen species. Five of these are united in two species by Ogilvie-Grant, and seven which inhabit the area dealt with by Rothschild and Hartert are allowed by these authors only subspecific rank under two specific names. On the other hand, the species *M. macgillivrayi*, which is united by Oustalet with the widely extended *M. duperreyi*, and regarded as only a subspecies by Rothschild and Hartert, is reckoned a distinct species by Ogilvie-Grant.

The peculiar nesting habits of the Megapodiidæ are well known. Most of the species scrape together large mounds of earth or sand, with or without vegetable matter, and the female deposits her eggs, which are very large for the size of the bird, at intervals of several days, in excavations in these mounds. Incubation is effected by the heat of the slowly fermenting mass, aided by that of the sun, or by the sun alone; and the young are hatched in an advanced state of plumage. They receive no attention from their parents, and in some cases at least they are able to fly on the day on which they are hatched. In some species many pairs of birds frequent the same mounds or laying-grounds.

In almost all the countries where Megapodes occur, their large eggs are highly valued by the natives as food, and their laying-places are frequently visited for the purpose of obtaining them.

* Catalogue, Vol. xxii. 1893. Also 'Game Birds': Allen's Naturalists' Library, London, 1895-7.

† "Notes on Papuan Birds." *Novitates Zoologicae*, vol. viii. p. 135, 1901.

There is clear evidence that the birds are at least semi-domesticated in some localities.

Mr. C. M. Woodford*, speaking of *M. brenehleyi* (*M. eremita* of B. M. Catalogue) on Guadalcanar, in the Solomon Islands, says: "The birds lay in open sandy clearings, generally near the sea, which are kept clear of shrubs and undergrowth by the natives, and by the sand being constantly turned over by the birds Many thousands of birds congregate at the same place, the laying-yards being often some acres in extent." Of the little island of Savo, to the north of Guadalcanar, the same author writes †: "although only about the size of a large pigeon" the megapode "lays an egg bigger than that of a duck," and "eggs form an important item in the daily food-supply of the natives." "The megapodes lay their eggs on two large cleared sandy spaces and nowhere else on the island. Upon these no weeds or grass can grow as the ground is constantly being turned over by the birds when digging holes to lay their eggs, and by the natives when in search of them. The sandy spaces are fenced off in plots which belong to different owners." He adds that the natives are quite indifferent as to the condition of the eggs when they eat them, it is all the same to them whether they are newly laid or well advanced towards hatching.

Mr. John Brazier, writing of a collection of eggs of Megapodes exhibited before the Society: says ‡, "When at San Christoval" (in the Solomon Islands) "I was shown an egg that Perry, a white man living there these last five years, said was laid by the 'Wild Fowl,' and upon my visiting him a few days later, he had just obtained another from the nest of his domestic fowls."

M. Freycinet, in his narrative of the voyage of the Uranie §, says of the species which was discovered by this expedition on the Marianne Islands: "Espèce de gallinacée de couloir noir que jadis les anciens Mariannais élévoient auprès de leurs cabanes; elle est aujourd'hui fort rare. Nos naturalistes lui ont donné le nom de Mégapode la Pérouse."

In the volume on Zoology (p. 125) of the same work the naturalists Quoy and Gaimard say of *M. freycineti*, which they discovered on the island of Waigiou, to the west of New Guinea, and which is now known to occur from the Moluccas to Western New Guinea: "Sur les îles Vaïgion et Boni, ces oiseaux paroissent vivre dans une demi-domesticité, à-peu-près comme les canards qui habitent les marais que traverse la petite rivière de Sèvre, (Charente Inférieure)." One, brought by the natives, lived several days on the Uranie.

Professor J. Stanley Gardiner, whose investigations of the Fauna and Flora of the Maldive and Laccadive Islands are well

* The Naturalist among the Head-hunters, pp. 100-101.

† P. Z. S. 1888, pp. 249 & 250.

‡ P. Z. S. 1874, p. 607.

§ Voyage autour du Monde sur les corvettes de S.M. l'Uranie et la Physicienne. 1817-1820. Paris, 1825.

known, informs me that a sultan of the Maldivé Islands, who died in 1878, introduced *Megapodes* into an islet covered with cocoanuts and scrub, forming part of the great atoll of Malé in that Archipelago. Where these were obtained is not known, but Professor Gardiner thinks it probable that they were imported from the Nicobar Islands, between which group and the Maldives there is regular trade communication.

We have thus from four widely separated localities definite evidence of the more or less complete domestication of *Megapodes* by the natives. Finally Guillemard*, referring to Wallace's view that the Nicobar Island bird was introduced, says "that this is not impossible must be evident to every traveller in the Malay Archipelago, for birds of this genus are often seen in captivity."

With regard to the powers of flight of *Megapodes*, they are compared by some authors with those of barn-door poultry. Oustalet, however, recalls the fact† that a young specimen of *M. freycineti* flew on board 'La Coquille,' with a favouring breeze, when that vessel was "plus de deux milles" (over two miles) from land.

Le Souef‡ mentions that *M. duperreyi*, although the birds are "very poor fliers," occurs on the scrub-covered islands "a good many miles" from the N.E. coast of Queensland. He surmises that they may have been blown out during cyclones.

Finsch§ speaks of *M. senex*, the species inhabiting the Pelew Islands, as occurring on nearly all the sandy and rocky islands of the group. Some of these are separated by intervals of some three or four miles. He considers that the bird, "which is a good flier" (the term is of course used in a relative sense), may occasionally fly from one island to the other. He also mentions that the eggs are systematically taken by the natives.

But when all allowance is made for their powers of flight, it would seem an extravagant suggestion, and one which I think has never been made, that *Megapodes* could by this means have reached the outlying islands in which they are now found. The Pelew Islands are separated by nearly five hundred miles from the Philippines, the nearest land to the west, and by a rather greater distance from New Guinea to the south. The Marianne Islands are some 600 miles to the E.N.E. of the Pelew Islands. Niuafou is nearly 1000 miles to the east of the New Hebrides, the nearest islands to it on which a species of *Megapode* exists.

We may now examine the geological nature and some other conditions of these outlying islands in the Pacific on which *Megapodes* are found, as well as the characters of the species living on them.

The island of Niuafou, or New Hope Island, although politically part of the Tonga group, is situated almost halfway between

* Cruise of the Marchesa, vol. ii. p. 122 (footnote), 1886.

† *L. c.* vol. xi. p. 69.

‡ *Ibis*, 1899, p. 16.

§ "Die Vögel der Palau-Gruppe." *Journal des Museum Godeffroy*, Heft viii. Bd. iii.) 1875, p. 30 (p. 162 of the volume).

the Fiji and Samoa Islands. It is described in Findlay's South Pacific Directory* as a volcanic island with black lava rocks all round the shores. It is 3 to 3½ miles across, well wooded, and some 500 to 600 ft. high. In the centre is a brackish-water lake at sea-level in which are hot springs. Friedländer †, who visited the island in 1897, describes his visit to the nesting places of the birds, which are on the shores of this lake. He had to swim round some of the rocky points to reach them, and found the temperature of the water that of a warm bath, and the rocks under water too hot, in places, to rest his hands on them. He says the island is an intermittently active crater, largely composed of basaltic rock. An eruption occurred in 1886, when the whole island was covered with ashes, and the Megapodes were nearly exterminated. Owing to the 'tabu' imposed by the chief their numbers had increased again, so that there was a fair number at the time of his visit. The birds do not build mounds, as do many of their congeners, but lay in holes which they excavate in the volcanic sand. He is inclined to attribute the heat of the sand, which he found on digging for the eggs, to the volcanic action. We may note in passing that P. & F. Sarasin ‡ found that the Maleo (*Megacephalon maleo*) of Celebes lays in the neighbourhood of hot springs, as well as on the sea-shore.

The birds of Niuafoou were collected by Mr. F. Hübner and described by Dr. Finsch §. With the exception of the Megapode all belong to common Tongan species, but Finsch remarks on the absence from the collection of four species (*Ptilotis carunculata*, *Halcyon sacra*, *Lalage maculosa*, and *Colluricincla heinei*) which besides being common in Tonga are present, or represented by allied species, in Samoa and Fiji. At first sight it would appear that the absence of these species from Niuafoou might be attributed to the destructive eruptions of the volcano, but as these species are unrecorded from the not very distant group of Uvea (Wallis Id.), their absence from Niuafoou cannot certainly be attributed to that cause. It must be admitted, however, that a small volcano, still in intermittent activity, is the last place on which the remnants of an ancient fauna would be expected to survive. Had the bird been found on the high and ancient land masses of Fiji or Samoa, the case against this view would not have been so strong, but the birds of these islands have now been so fully collected as to make it in the highest degree unlikely that so large and useful a bird as a Megapode should have been overlooked in them.

The Niuafoou species, *Megapodius pritchardi*, was described by the late Sir Walter Buller in his Supplement || to the 'Birds of New Zealand,' and included, under the name of "The Southern

* 3rd edition, p. 558.

† "Ueber die Nestlöcher d. *Megapodius pritchardii* auf der Insel Niuafoou." Ornithologische Monatsberichte, vii. p. 37, Berlin, 1899.

‡ Zeits. d. Gesellschaft f. Erdkunde, Berlin, 1894, pp. 375, 388, 396 & 398.

§ Z. S. 1877, p. 782.

|| Vol. i. p. 31.

Megapode," in that fauna—on what appear to be wholly inadequate grounds.

In 1887, Mr. T. F. Cheeseman, the well-known Curator of the Auckland Museum, to whose knowledge and kindness many visitors to New Zealand are indebted, visited the Kermadec Islands, which are a scattered group lying nearly halfway between the North Island of New Zealand and the Tonga Islands to the N.N.E., and some 400 or 500 miles from either. Mr. Cheeseman reported* that a Mr. Johnson, who had resided on Sunday Island (a volcanic island, the most northerly of the group) about fifteen years before, told him that "prior to the eruption of 1876 a bird inhabited the floor of the large crater, which made mounds of sand and decayed leaves, two to three feet high, laying its eggs in the mounds. He was in the habit of visiting the mounds for the sake of the eggs and young birds, and has frequently taken 5 or 6 of the latter from the same nest at one time." The eruption of 1876 covered the floor of the crater and apparently killed out the species. Mr. Cheeseman cautiously observes that the evidence, such as it is, seems to point to the former existence of a species of *Megapodius* on this island.

We may remark that the statement that five or six young birds were taken from the same nest at one time is hardly in accordance with the habits of the genus, for the eggs being laid at some intervals the young ones are not of the same age, and leave the mounds to feed for themselves soon after they are hatched. The statement would be more appropriate to the young of the Grey Duck (*Anas superciliosa*) which frequents this island. It is the mound-building habit which, as Mr. Cheeseman says, "seems to point" to the existence of a Megapode on Sunday Island.

Sir Walter Buller † on the strength of this evidence includes *Megapodius pritchardi* among the birds of New Zealand, in which region the Kermadec Islands are included. He says: "I have no doubt whatever in my mind—notwithstanding the apparent difference in their nesting habits—that Mr. Cheeseman was right in his conjecture" that the Sunday Id. and Niuafoou birds were identical. (It will be noted that Mr. Cheeseman conjectured that the genus, not the species, was identical.) On the discrepancy that whereas the Niuafoou bird lays in burrows, the Sunday Id. bird is stated to have built mounds of sand and leaves two to three feet high, he remarks (p. 33): "If the latter observation was accurate it may have been due to circumstances of locality and environment, and by no means negatives the assumption of these birds being one and the same species." As we have seen, the statement that the Sunday Island bird built mounds is the only evidence we have of the existence of a Megapode on that island.

Through the kindness of Mr. Ogilvie-Grant I have had the good

* "On the Birds of the Kermadec Islands." Trans. and Proc. of the N. Zealand Institute, vol. xxiii. (1890) p. 219.

† Supplement to the Birds of New Zealand, vol. i. (1905) p. 31.

fortune to meet at the Natural History Museum Mr. Iredale, who has recently resided on the Kermadecs with the object of studying their fauna. He assures me that he was not able to obtain any confirmation of the report of the existence of a Megapode on Sunday Island which was given to Mr. Cheeseman, and finds that the successors of his informant are not inclined to regard that report as worthy of very serious consideration.

It therefore seems to me that we have no good evidence that the genus *Megapodius* formerly inhabited the Kermadec Islands and absolutely none that *M. pritchardi* lived there.

One good result, however, we owe to Sir Walter Buller's enthusiasm in claiming this species as a member of the New Zealand fauna, and that is a plate representing the bird in a condition of plumage not hitherto figured.

M. pritchardi belongs to the section of the genus with the back and upper surface of the wings rufous brown, the breast and belly lead or slaty grey, and in its general coloration perhaps is nearest *M. cumingi*, Dillw., of the Philippines and Borneo. In the type specimen described and figured by G. R. Gray*, and now in a somewhat dilapidated condition in the British Museum, the bases of the quill-feathers, except the first, are white; there is also some white among the upper tail-coverts. A specimen in the Leyden Museum was described by Schlegel † (and I have had an opportunity of examining it) which has, as he observes, the upper tail-coverts pure white. The first specimen which came to the Auckland Museum was described by Buller ‡. It had no white on either quill-feathers or tail-coverts, though the rectrices were white at the base §. As it was not known then that this skin came from the same locality as *M. pritchardi*, and it differed so considerably from the type of that species, it was described by Buller as a new species—*M. huttoni*.

Buller's plate (pl. ii.) in the Supplement to the 'Birds of New Zealand' shows no white in the plumage. In the description he says (p. 32):—"Although absent in this specimen" (that named *M. huttoni* and perhaps the specimen figured in the plate) "most examples have a patch of white covering the basal parts of the primaries and secondaries, the extent varying in almost every individual. Some also have white markings on the upper tail-coverts and basal part of the tail-feathers."

It appears then that the feature by which *M. pritchardi* stands apart from all other species of the genus—the occurrence of white at the bases of the primaries and elsewhere—is a varying and inconstant character.

To return to the comparison with *M. cumingi*, I find that *M. pritchardi* has the top of the head slaty-brown rather than brown, the sides of the head rather paler, the mantle brown tinged with slate rather than olive-brown, and the belly a paler brown.

* P. Z. S. 1864, p. 41, pl. vi.

† Mus. Pays-Bas, viii. p. 64.

‡ Transactions of the N. Zealand Institute, vol. iii. (1870) p. 14.

§ Hutton, Trans. N. Zealand Institute, iv. (1871) p. 165.

We may note that the species inhabiting the New Hebrides, *M. layardi*, belongs to the group of species having the mantle and upper parts blackish grey, not rufous brown as in *M. pritchardi*.

There is one other fact which seems to point to the view that the Niuafoou bird is not indigenous to that island, viz., that the native name, *Mallow*, is the same as that applied to several species of Megapodiidae in the Malay Archipelago. This appears in the specific name of *Megacephalon maleo* of Celebes. *Megapodius cumingi* is called *moleo kitjil* (= little moleo) by the natives of that island, in distinction, probably, from the larger *Megacephalon maleo**. *M. layardi* is the *Malow* of the natives of the New Hebrides. Oustalet says that this name appears to be applied indifferently to Megapodes by Malay hunters. Its occurrence on Niuafoou, far out in the Pacific among a population of Polynesian speech, seems to suggest strongly that at some time the name arrived at the island with the bird.

With regard to the Marianne and Pelew Islands, I have less evidence to bring forward, but it was in the former group that Quoy and Gaimard were told that the Megapode (*M. laperousii*) had been domesticated. It is so closely similar to *M. senex* from the Pelew Islands that M. Oustalet has regarded them as of the same species †.

The geological structure of the Pelew Islands is discussed by Semper ‡, who shows that the islands are composed in part of raised coral, in part of volcanic rock, formed during submarine eruptions. If this is the case, there can be no remains on the Pelew Islands of the fauna of a subsided land-mass, supposing such a mass to have existed.

From the description of the Marianne Islands in the account of the Voyage of the Uranie, above quoted, it is stated (Historique, T. 2, p. 253) that they seem to have been formed in the remote past by submarine eruptions, which have raised the floor of the ocean, and that the reefs which have formed about the islands as they have risen above the waves have since been raised with them. So that it would appear that the same remark is applicable to these as to the Pelew Islands.

M. laperousii and *M. senex* have the upper parts blackish grey, as have *M. freycineti*, from the Moluccas and New Guinea, *M. geelinkianus* from New Guinea and some adjacent islands, and *M. layardi* from the New Hebrides. But they differ from these and other species in the french-grey colour of the feathers of the head. We must conclude therefore that this character has been developed since their isolation, or else that the parent stock has either not yet been discovered, or has become extinct.

In the British Museum Catalogue three "doubtful species"

* Meyer & Wieglesworth, Birds of Celebes, vol. ii. 1898, p. 671.

† Cf. Ogilvie-Grant, Allen's Naturalists' Library: Game Birds, vol. ii. p. 182.

‡ The Natural Conditions of Existence as they affect Animal Life, by Karl Semper, Chapter 8: International Scientific Series, vol. xxxi. London 1883, pp. 234 & 264.

are mentioned (p. 446) by Ogilvie-Grant, viz.: 1. Young birds said to have been obtained on Lord Howe's Island; 2. The Megapode of Sunday Island in the Kermadec group; and 3. *M. ? andersoni* of Gray from New Caledonia. The first of these Mr. Ogilvie-Grant assures me is now known to have come not from Lord Howe's Island, but from New Hope Island, another name for Niuafoou. With the second I have already dealt. The third is based on a reference in the MS. of Anderson, who accompanied Cook's third voyage, to a bird he called *Tetrao australis* and briefly described as follows:—"fusca nigraque; pedibus nudis." The subsequent exploration of New Caledonia has not revealed the presence of a Megapode on that island.

To sum up: There is evidence of the domestication or semi-domestication of Megapodes in several parts of the area they inhabit,—viz., in the Solomon Islands, Western New Guinea and the Marianne Islands, and of their introduction into the Maldive Islands. There is no satisfactory evidence that a Megapode has ever existed on any Pacific island east of a line bordering the Philippines, Solomon Islands, and New Hebrides except the Pelews, Marianne Islands, and Niuafoou. The geological character of these islands, so far as we know it, lends no support to the view that they could preserve the fauna of a sunken land-mass. The birds of the Pelew and Marianne Islands are almost identical, and on the latter group they were domesticated. The bird of Niuafoou is called by a Malay name.

When we consider the complex movements of the races of the Western Pacific, of which there is much anthropological evidence, and how easily Megapodes might be introduced into a new locality by a canoe provisioned with their eggs, which are a staple native food, it would appear that we have in human agency a probable key to some of the anomalies of their distribution.

The analogy of the distribution by native agency of domestic fowls, cousins of the Megapodiidæ, and of the dogs and pigs which were found by the early voyagers on the Pacific Islands, is obvious.

How far the same cause may have been operative within the main area occupied by the genus, and have given rise to the anomalies in the distribution of the species alluded to by Oustalet, is too large and complex a subject for me to attempt to deal with.

The Savo natives, says Mr. Woodford,* speaking of *M. eremita* of the Solomon Islands, have a curious legend connected with this bird. They hold the Shark in great veneration and say that their island was made by the Shark, who brought stones together and placed upon them a man, a woman, the Yam plant, and the Megapodes. Things went well for a time and the people increased and so did the Megapodes. At last the people went to the Shark and complained that the Megapodes made havoc among the yam

* C. M. Woodford, P. Z. S. 1888, p. 249.